VERIFICATION SAMPLING AND ANALYSIS PLAN PHASE I LEAD ABATEMENT GOLDEN GATE BRIDGE SAN FRANCISCO AND MARIN COUNTIES, CALIFORNIA

JANUARY 17, 1997

PES Environmental, Inc.
Engineering & Environmental Services

GOLDEN GATE

FOLDOUT

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Engineering & Environmental Services

A Report Prepared For:

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1.0 INTRODUCTION

This Verification Sampling and Analysis Plan (VSAP) has been prepared by PES Environmental, Inc. (PES) on behalf of the Golden Gate Bridge, Highway and Transportation District (District) as part of the Phase I Lead Abatement to be performed during the seismic upgrade of the north and south approaches of the Golden Gate Bridge (Plate 1). The Phase I Lead Abatement consists of removal of lead-bearing sandblast media (SBM) and lead-affected soil in areas to be accessed for the seismic upgrade construction activities. The purpose of shallow soil sampling and chemical analysis described herein is to verify that the remedial goals have been achieved.

As a result of historic sandblasting activities associated with bridge maintenance, the ground surface beneath and in the vicinity of the bridge contains SBM with elevated concentrations of lead, primarily from lead-based paint.

Remedial investigation (RI) of the site has been performed and is summarized in this VSAP. The RI and subsequent remedial planning were conducted under the oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). The District is preparing to perform the removal action in accordance with the approved remedial action plan (RAP) entitled, *Golden Gate Bridge Seismic Retrofit Project Phase One, Lead Cleanup and Site Preparation, Final Remedial Action Plan* dated March 1, 1996 and prepared by Entrix, Inc. Phase I removal action areas include those areas which will be disturbed or otherwise used for construction during the bridge seismic retrofit work. The limits of the Phase I removal action areas are shown on the Site Plan, Plate 2.

1.1 Content and Format

This VSAP is comprised of three primary components: (1) a Field Sampling Plan (FSP); (2) a discussion of Quality Assurance (QA) objectives; and (3) a discussion of the statistical data evaluation techniques.

This VSAP includes the following elements:

Section 1.0 - Introduction. The introduction presents an explanation of the objectives of the sampling program and the purpose and structure of the VSAP.

Section 2.0 - Site Background. This section describes the physical and historical setting of the site and presents a summary of previous environmental investigations.

Section 3.0 - Field Sampling Plan. This section describes the field sampling program and the procedures and methodologies that will be followed during the verification sampling and analysis.

Section 4.0 - Quality Assurance Program. This section describes the purpose and objectives of the quality assurance/quality control (QA/QC) program. It also presents the policies, functional activities and QA/QC protocols to ensure that the data generated are of acceptable quality.

Section 5.0 - Data Evaluation. This section describes the procedures to be followed for data analysis, including statistical data reduction methods to evaluate whether remedial goals were achieved and to identify areas where additional remedial action is necessary.

1.2 Verification Sampling Objectives

The objectives of the verification sampling are to:

- Evaluate whether remedial goals were achieved by the soil and SBM removal activities;
- Identify areas where additional soil and SBM removal is required; and
- Document that conditions following soil and SBM removal meet the human health risk-based remedial goal.

2.0 BACKGROUND INFORMATION

The site background information summarized in this section is discussed in detail in the *Golden Gate Bridge Seismic Retrofit Project Phase One, Lead Cleanup and Site Preparation Final Remedial Action Plan* (RAP) dated March 1, 1996 (Entrix, 1996).

2.1 Site Location

The Golden Gate Bridge spans the Golden Gate, which is the body of water which separates Marin County from San Francisco County (Plate 1). The Golden Gate is also the boundary between the waters of the Pacific Ocean to the west, and San Francisco Bay to the east.

The North Approach and the South Approach of the Golden Gate Bridge are the two areas which are addressed in this VSAP. The South Approach is located at Fort Point, within the Presidio, which is part of the Golden Gate National Recreation Area (GGNRA) in the city and county of San Francisco. The North Approach is located in the vicinity of Lime Point, Marin County, within the former East Fort Baker Military Reservation, which is also now part of the GGNRA. The GGNRA is managed by the U.S. Department of the Interior, National Park Service.

2.2 Physical Setting

The site is located on flat to steeply-sloping terrain. The ground surface at the site consists of paved and unpaved roads, soil and bedrock exposures. The soil and bedrock surfaces are sparsely vegetated. Remedial actions are to be performed primarily on the flat unpaved roads, and the flat to moderately-steep soil slopes.

2.3 Geology

The site is located within the California Coast Range geomorphic complex, and is underlain by rocks of the Franciscan Group. Rocks of the Franciscan Group in this area include folded and metamorphosed greenstones, cherts, and sandstones. The San Andreas and Hayward fault zones are found approximately 6 miles west and 17 miles east of the Golden Gate Bridge, respectively.

2.4 Summary of Site History and Operations

The Golden Gate Bridge, which is a steel suspension bridge, was completed in 1937 and was protected from corrosion by a coating consisting of red lead paint. The original red lead paint reportedly contained 68 percent lead, by weight. In 1965, due to corrosion concerns, a paint replacement program was instituted which included complete removal of the original red lead paint, rust and mill scale by sandblasting. An inorganic zinc silicate primer was applied on the southern portion of the bridge at that time. Zinc coating application on the south approach failed, and the zinc coating was removed by sandblasting. Lead-based paint removal by open sandblasting from structures at the south approach was completed by 1975, and from structures at the north approach by 1994. Maintenance activities have resulted in the accumulation of spent SBM in areas beneath and in the near vicinity of the Bridge.

The planned Phase I lead removal action is being undertaken on an accelerated schedule to accommodate the seismic upgrade of the bridge foundations. Other areas of the site, outside of the Phase I removal areas, are being addressed under a Phase II program to assess the nature and extent of lead-affected soil, evaluate human health and ecological risks, and perform remedial actions, as appropriate.

2.5 Summary of Previous Investigations

Initial evaluation for the presence of lead in surficial soil and spent SBM in the vicinity of the Bridge was performed in May 1992 (Health Science Associates, 1992). Results of that evaluation identified elevated lead concentrations in soil beneath the approach structures. GGNRA had an additional investigation performed which identified elevated lead concentrations in soil in the vicinity of the Lighthouse Keeper's Bluff (Questa Engineering, 1992). Entrix, Inc. performed an investigation designed to provide vertical definition of lead in soil, sand and roadbase at the South and North approaches (Entrix, 1994). The results of all previous investigations have been incorporated into the lead removal project areas identified in

the RAP (Entrix, 1996). Although zinc was also detected in soil samples collected from the South Approach, the zinc concentrations were found to be well below established regulatory criteria.

A human health risk assessment was performed by Entrix using the DTSC computer simulation model *Leadspread Pb6 (version Pb6)*. The objective of the assessment was to estimate the concentration of total lead that can remain in soil within the Phase I removal areas and still be protective of worker health during the seismic retrofit activities. The determining criteria was a 95-percent confidence that blood lead levels for the exposed population will not exceed 10 µg/deciliter. Using a site-specific exposure scenario for a seismic retrofit worker, a risk-based remedial goal of 1,396 milligrams per kilogram (mg/kg) lead in soil was determined. The risk assessment demonstrated that the worker population was the most sensitive exposure group. Therefore, the 1,396 mg/kg remedial goal is conservatively protective of other receptor groups that were studied.

Assessment of potential exposure to zinc, the secondary contaminant found at the South Approach, was also performed. The assessment compared known zinc values collected during soil and SBM sampling to the EPA preliminary remediation goals (PRGs) which are conservative health risk-based goals for generalized exposure scenarios (EPA, 1996). The PRG for zinc in an industrial exposure setting is 100,000 mg/kg, and 23,000 mg/kg for a residential setting. A conservative remediation goal of 5,000 mg/kg zinc in soil was chosen. All detected concentrations of zinc in soil were well below this concentration.

2.6 Removal Action Areas

Based on the results of previous investigations, several areas at the site have been identified to contain soil, SBM or gravel roadbase which contain concentrations of lead exceeding the remedial goal. These areas are segregated into five sub-areas on the basis of topography and access. The sub-areas are shown in detail on Plates 3 through 5, and include:

- The South Approach, excluding Lighthouse Keeper's Bluff (Sub-area S-1);
- The Lighthouse Keeper's Bluff portion of the South Approach (Sub-area S-2);
- The Conzelman and Moore Road Areas of the North Approach (Sub-area N-1);
- The portion of the North Approach that is south of the North Anchorage House (Sub-area N-2); and
- The portion of the North Approach that is north of the North Anchorage House (Sub-area N-3).

Although there will be no seismic retrofit construction occurring within Sub-area S-2, the district has elected to perform limited removal of surficial soil and SBM during the Phase I Lead Abatement in this sub-area. Removal of surficial soil and SBM in Sub-area S-2 is

desirable because it is at a higher elevation than portions of Sub-area S-1, where seismic retrofit work will occur. To protect subsurface features of historical significance, removal action in Sub-area S-2 will be limited to non-excavation methods, such as vacuuming and sweeping of surficial soil and SBM.

3.0 FIELD SAMPLING PLAN

3.1 Purpose of Field Sampling Plan

Verification soil samples will be collected following removal of SBM and affected soil to verify that soil containing lead at concentrations above the remedial goal does not remain in areas where seismic retrofit work will occur. If seismic retrofit areas are found to not meet the criteria, additional soil removal will be performed in those areas and additional verification samples collected.

It is anticipated that removal of surficial soil and SBM at Lighthouse Keeper's Bluff (Sub-area S-2) will result in meeting the Phase I remedial goals. The purpose of VSAP sampling in Sub-area S-2 is to document the residual lead concentrations that remain after the removal action. These concentrations will be evaluated during Phase II of the project.

The FSP describes the field procedures to be utilized for the verification sampling program, and presents: (1) the rationale for the field program; (2) a description of the procedures to be followed to select sampling locations; (3) field procedures and methodologies; and (4) the analytical program.

3.2 Performance Standards and Guidance

Work will be performed in accordance with applicable guidance and requirements set forth pursuant to Comprehensive Environmental Response Compensation Liability Act (CERCLA) as amended by Superfund Amendment and Reauthorization Act (SARA); applicable federal and state requirements (ARARs); the National Contingency Plan (NCP); DTSC; and Superfund practices in effect at the time of performance of the activity or element of work.

Verification sampling will be conducted in general accordance with the following documents:

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, U.S. EPA, Office of Emergency and Remedial Response, October 1988, OSWER Directive No. 9355.3-01.

Interim Guidance on Potentially Responsible Party Participation in Remedial Investigation and Feasibility Studies, U.S. EPA, Office of Waste Programs Enforcement, Appendix A to OSWER Directive No. 9355.3-01.

A Compendium of Superfund Field Operations Methods, Two Volumes, U.S. EPA, Office of Emergency and Remedial Response, EPA/540/P-87/001a, August 1987, OSWER Directive No. 9355.0-14.

EPA NEIC Policies and Procedures Manual, May 1978, revised November 1984, EPA-330/9-78-001-R.

OSHA Regulations in 29 CFR 1910.120 (Federal Register 45654, December 19, 1986).

Preparation of a U.S. EPA Region 9 Field Sampling Plan for Private and State-Lead Superfund Projects, Document Control Number 9QA-06-89, August, 1993, U.S. EPA Region 9, Quality Assurance Management Section.

3.3 Design and Placement of the Sampling Grid

The Phase I removal area is partitioned into five sub-areas (Plates 3 through 5). A grid composed of cells measuring 40 feet by 40 feet in plan view (each cell approximately 1,600 square feet in area) is superimposed in a north to south, west to east orientation onto both the southern and northern approaches. The grid encompasses each of the sub-areas and is designed so that it may be extended in the future to include projected Phase II removal areas, if needed. West-east oriented grid lines are identified with sequential numbers (i.e., 1, 2, 3...). North-south oriented grid lines are identified with alphabetical letters (i.e., A, B, C...). Grid nodes are thus identified with a letter and number identification code corresponding to grid lines that intersect at that node. Plate 6 is a schematic diagram identifying how the grid will be constructed. Each grid cell is identified by the code of the grid node at the northwestern corner of the cell.

The cell dimensions of the sampling grid were selected to generate sufficient sample data within each sub-area to allow for statistical data evaluation. The verification sampling grid is significantly smaller than the sampling grid used to characterize lead concentrations in soil within the Phase I removal area to increase the level of confidence that the remedial goal has been achieved. The sampling frequency results in a sample density approximately three times greater than that of the RI.

To establish the verification soil sample grid, a surveyor will be used to locate perimeter grid nodes. Grid nodes will be established utilizing either traditional surveying techniques or use of Global Positioning Satellite (GPS) receivers. GPS technology is the preferred method because of its accuracy, portability and real-time data availability. However, interferences to satellite signals from the steel bridge may render the equipment unsuitable at certain locations; traditional surveying techniques will be employed at these locations if needed.

Once the survey crew has located a perimeter grid node, the crew will mark the ground surface with fluorescent construction paint and insert a 6-foot high metal stake driven securely into the ground surface. The stake will have an attached plate identifying the grid node. The stake will be labeled with the following information: (1) sub-area identification; and (2) north-south and east-west orientation codes.

Following SBM and affected soil removal activities, the internal grid node locations will be identified using a graduated tape measure and the staked perimeter nodes as the measurement references. Internal grid node locations will be identified by driving wood surveyor stakes into the ground surface. The stakes identifying internal grid node locations will be marked with fluorescent paint and a node identification number. The node identification number will include the north-south and east-west orientation code.

3.4 Soil Sampling Field Procedures and Methodology

3.4.1 Verification Sample Strategy

One four-point composite verification soil sample will be collected from each cell. All cells that lie completely within a removal area will be sampled. Samples will be collected from cells that partially overlay a removal area (i.e., cells along borders) only when more than 50 percent of the cell overlays the removal area.

Each cell will be visually partitioned into four equal quadrants and one composite sub-sample will be collected from the approximate center of each quadrant. Samples will be collected by placing approximately 2 ounces (oz.) of soil from each of the quadrant locations into 8 oz. jars. Sub-sample locations and the number of sub-samples comprising a grid cell composite sample may need to be adjusted in the field if removal of surface material results in exposure of concrete or bedrock. The actual number and location of verification samples will be established by the field supervisor.

3.4.2 Sample Equipment and Containers

The following is a summary of equipment which will be used during verification sampling activities:

- Hand trowel;
- 2 ounce stainless steel measuring cup;
- Tape line (in feet and inches);
- 8 ounce precleaned glass sample jars;
- Zip-lock plastic bags;

- Surveyor pin flags;
- Personal protective equipment;
- Pre-moistened towelettes;
- Ice, insulated cooler and appropriate packing supplies;
- Buckets, brushes and detergents for equipment decontamination;
- Sample labels;
- Chain-of-custody forms; and
- Field notebook, sample collection log, sub-area field map, water-resistant ink pen, and daily field report forms.

3.4.3 Sample Collection Procedure

Verification soil samples will be collected from the ground surface using a pre-cleaned hand trowel. Sampling will be directed at the site by the engineer or geologist and will be conducted according to the procedures described below.

A precleaned trowel and graduated 2 ounce measuring cup will be used to scoop approximately 2 ounces of soil from the ground surface near the center of each quadrant. The soil will be placed into clean 8 ounce glass containers provided by the laboratory. The sample containers will be covered with Teflon-lined lids, labeled, and placed in a chilled cooler for shipment to the laboratory.

3.4.4 Equipment Decontamination

The sample collection equipment will be cleaned with a mild phosphate-free detergent solution and rinsed with potable water between composite sample locations or by using sterilized, pre-cleaned and moistened towelettes. Decontamination fluids, if generated, will be stored in drums or tanks pending characterization and disposal. Solid waste materials (i.e., spent decontamination towelettes, gloves, paper towels, etc.) will be stored in drums or bins pending disposal.

3.4.5 Sample Preservation

Sample jars will be sealed with Teflon-lined lids to prevent moisture entry and loss. Sample containers will be labeled and placed in a thermally insulated cooler that is chilled to a temperature of approximately 4 degrees Centigrade for transport to the project analytical laboratory under chain-of-custody protocol.

3.4.6 Sample Labels

The samples will be identified using a numbering system which will consist of: (1) the cell identification (see Plate 6), and (2) the date the sample was collected. Samples will be identified with a label affixed to the sample jar. The following information will be specified on each label:

- Project name;
- Project number;
- Sample identification number; and
- Analyses requested.

3.4.7 Sample Packaging and Shipment

Individual sample containers will be placed in sealed plastic bags to prevent intrusion of moisture into sample containers and damage to sample labels. The coolers will be chilled using ice packaged in doubled plastic bags to prevent leakage of water. The cooler will be sealed with strapping tape prior to transport to the analytical laboratory. Coolers will be transported to the laboratory either by laboratory couriers or field sampling personnel.

Samples will be accompanied by 3-copy, pressure sensitive chain-of-custody documents. The form will accompany every sample shipment to the analytical laboratory to document sample possession from the time of collection. The form will contain the following information:

- Sample identification number;
- Signature of collector;
- Date and time of collection;
- Site name and project number;
- Sample matrix;
- Sample container description;
- Analyses requested;
- Special analytical procedures requested;

- Remarks (expected interference's, hazards, unusual events at the time of sampling, if applicable);
- Preservatives added (if any);
- Any special sample preparation (if applicable);
- Destination of samples (laboratory name);
- Signature of persons involved in chain of possession (relinquished by and received by); and
- Date and time of sample receipt at laboratory.

The two top sheets of the chain-of-custody form will be placed in a water-tight plastic bag which will be taped to or placed in the cooler for transport.

When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and record the time on the chain-of-custody form. A separate chain-of-custody form will accompany each sample shipment. The method of shipment and courier name(s) will be entered on the chain-of-custody form.

3.4.8 Field Documentation

Daily field activities will be recorded on daily field report forms which indicate the date and time of field observations made by field personnel. Examples of daily report forms, sample labels, and chain-of-custody documents are presented in Appendix A. All field forms will be signed by field personnel.

Composite sub-sample locations will be identified with a surveyor pin flag following sample collection. The sample identification code along with the initials of the person collecting the sample will be inscribed on each pin flag. In addition, a sample collection log will be maintained to record daily sample collection activities as they relate to the progress of the investigation. Information pertinent to soil sampling will be recorded in water-resistant ink in a hard bound log book. Entries in the log book will include the following information:

- Area identification (e.g., North Approach);
- Purpose of sampling;
- Location of sampling site (sub-area and cell coordinates);
- Names and affiliations of all sampling team members;

- Surficial lithology of each sample;
- Date and time of sample collection;
- Description of deviations from sampling plan (if any);
- Sample distribution (e.g., name of laboratory); and
- Signature of personnel responsible for sampling.

3.4.9 Corrections to Documentation

Original data recorded in field logs, chain-of-custody forms, and on other forms will be written in water-resistant ink. None of these documents will be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document assigned to one individual, that individual will make corrections by drawing a line through the error, entering the correct information, and initialing and dating the change. The erroneous information should not be obliterated. If possible, any subsequent error(s) discovered on a document will be corrected by the person who made the entry.

3.5 Laboratory Procedures and Methodology

Samples will be analyzed at one or more laboratories that are certified by the California Department of Health Services for performing the analyses specified in Section 3.5.3. Sample handling procedures used by the laboratories may vary from the procedures specified herein as long as they fulfill the objective of maintaining sample integrity and traceability.

3.5.1 Sample Inspection

The sample custodian at the laboratory accepts custody of delivered samples and verifies the following information:

1. All samples are present;
2. All samples are in good condition;
3. All samples are accompanied by a properly completed chain-of-custody form;
4. The sample identification is complete and corresponds to the chain-of-custody form; and
5. The condition of custody seals and temperature of the chest.

If sample integrity is questionable, the sample custodian will immediately notify the laboratory's project administrator, who in turn will notify the project manager. Arrangements can then be made for sample replacements to be shipped to the laboratory. The sample custodian will document the sample condition on the sample custody log and sign the chain-of-custody form.

3.5.2 Logging of Laboratory Samples

After chain-of-custody procedures are complete and acceptable, the sample custodian will assign laboratory identification numbers to the samples. Laboratory sample identification numbers may be written on the chain-of-custody form for tracing purposes. The custodian will transfer the samples to the proper analyst(s) or store the samples in an appropriate secure area.

Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted. Data sheets and laboratory records are retained as part of the permanent documentation for at least three years.

3.5.3 Sample Preparation and Analysis

Samples collected from each grid will be thoroughly homogenized in the laboratory to ensure sample uniformity. Homogenization will be performed by thoroughly mixing the sample prior to obtaining a portion for digestion. Homogenization will be verified by the laboratory by analysis of duplicate samples as described in Section B-6.1.2.3.

The program for the analysis of soil, SBM and roadbase samples will include analysis for lead by EPA Method 3050 (acid digestion) and EPA 6010 Series methods (inductively coupled plasma spectroscopy [ICP]) following the procedures outlined in U.S. EPA's *Test Methods for Evaluating Solid Waste* (SW-846) (EPA, 1986). In addition, twenty five percent of the verification samples submitted from the southern approach will be analyzed for zinc by EPA 3050/6010 Series methods. The samples to be analyzed for zinc will be selected randomly.

The analytical laboratory reporting limit objective is 5.0 mg/kg for both lead and zinc using ICP methods.

3.5.4 Sample Storage

Samples and extracts are retained by the analytical laboratory for up to 30 days after the data are reported by the laboratory. Unless notified by the program managers, excess or unused samples will be disposed by the laboratory in a manner consistent with appropriate government regulations.

4.0 QUALITY ASSURANCE PROGRAM

The purpose of the QA program is to establish uniform baseline procedures, guidelines, and inspection protocols designed to produce environmental data of acceptable comparability and quality. The QA program specifies the data quality objectives, policies, organization, activities, and specific quality control (QC) procedures for verification sampling activities. Any amendments to the QA program will be submitted to the DTSC for approval prior to implementation. A detailed discussion of specific QC procedures which will be followed during this project are presented in Appendix B.

The objectives of the QA program are to develop and implement procedures for obtaining and evaluating data in an accurate, precise, and complete manner so that analytical data, sampling procedures, and field measurements provide information that is internally comparable and representative of actual field conditions. Furthermore, it is an objective of the QA program that data collection procedures will be sufficiently documented so that data are traceable and legally defensible in a court of law.

The data quality objectives (DQOs) specify the quality of data required to support remedial completion decisions. Measurements of the quality of data include the following parameters: precision, accuracy, representativeness, completeness, and comparability (PARCC). Definitions of these terms and procedures to be followed to achieve these DQO's are presented in Appendix B.

The QA program establishes procedures to produce technical products of consistent quality. This uniformity will be accomplished through the formal standardization and documentation of field and laboratory techniques and activities. In addition, project deliverables will be distributed and reviewed in accordance with specific guidelines. All field and laboratory activities will be coordinated and reviewed to assure consistency with overall project objectives.

Project deliverables resulting from these activities will be submitted to project quality assurance personnel for review.

5.0 DATA EVALUATION

5.1 Closure Criteria

The District has developed site-specific closure criteria for the Phase I areas based on the remedial goals established in the human health risk assessment (Entrix, 1996). The closure criteria was established to assess whether the human health risks at the site have been mitigated. The DTSC has approved a site-specific acceptable total concentration of lead in soil of 1,396 mg/kg.

The sampling and analysis program has been designed to generate a sufficient sample population from the Phase I removal areas to apply statistical methods to the data to identify whether the verification sample results indicate that the established remedial goals have been achieved. The statistical methods were developed in accordance with the methods described in SW-846 and *EPA's Methods for Evaluating the Attainment of Cleanup Standards* (EPA, 1989a). This method involves performing a separate statistical analysis of the verification sample results for each sub-area.

The results of the verification samples will first be examined to verify that the spatial distribution of samples provide a reasonable representation of the affected area. Secondly, the data will be inspected to identify whether any individual samples exceed the remedial goals. If no samples exceed the remedial goals, the sub-area will be considered to meet the closure criteria. If some of the samples exceed the remedial goals, the spatial distribution of those samples exceeding the remedial goal will be qualitatively examined to identify whether trends exist that suggest that a significantly-affected area remains within the sub-area. If no trend is apparent, a statistical analysis of the data will be performed that identifies an "average" concentration of the sub-area. This method is described in detail below. Sub-areas at which the statistically-based "average" concentrations are below the remedial goals will be considered to have met the closure criteria.

5.2 Statistical Analysis Procedures

Statistical methods will be applied to the data to determine whether exceedance of the remedial goal by small populations of the verification samples are statistically significant or alternatively, whether the collective sample population indicates that remedial goals have been achieved. The statistical analysis will be used to assess the significance of outlying data and to evaluate the variability of the analytical results.

An upper limit for a sample population mean can be calculated with a desired level of confidence. For a 95-percent confidence that the mean of a sample population does not exceed a given value, this upper limit value is defined as the 95-percent upper one-sided confidence limit ($UL_{0.95}$). The calculation of $UL_{0.95}$ is based on the density distribution to which the population is assumed to belong, and the parameters which define the distribution as described below. If the $UL_{0.95}$, calculated from verification sample result data, is below the remedial goal established for a site, it is 95-percent probable the mean concentration in the area represented by the verification samples is below the remedial goal.

This statistical procedure will not be applied if all individual sample results from a sub-area do not exceed the remedial goal. Conversely, if there are significant individual sample result exceedances of the remedial goal, or if spatial data trends indicate remedial goals were not achieved in portions of a sub-area, the District may elect to perform additional removal action in portions of the sub-area.

If the $UL_{0.95}$ of a sub-area exceeds the remedial goal, then additional sampling will be performed following additional removal action. Data from cells which have been resampled will be evaluated in conjunction with the data from the portions of the sub-area already meeting the remedial goal.

5.3 Data Inference with Density Model Assignment

For sub-areas meeting the criteria for application of the statistical analyses, results of verification sample analyses will be tabulated for each sub-area to prepare the data sets for evaluation. Initial analyses will include visual examination of several different types of data plots and calculation of the mean and standard deviation of the data sets to identify a distribution to which the sample population conforms. The following plots will be constructed from the verification sampling data: (1) Histograms; (2) Population frequency distribution curves, which are plots of the relative frequency plotted on the y-axis (ordinate) versus the concentration plotted on the x-axis (abscissa); (3) Cumulative Frequency Distribution curves, which are plots of the rank order (data ordered from lowest to highest concentration) plotted on the ordinate versus the concentration plotted on the abscissa on probability paper.

Visual trends will be examined to assign a distribution which best represents the verification sample data set. To further evaluate the assignment of a population distribution, the Shapiro-Wilkes W-test (goodness of fit test) presented by Gilbert (1987) will be applied to the data sets from each sub-area. The W-test tests the null hypothesis to determine whether the data may belong to the assigned distribution.

5.4 Confidence Limits

In order to evaluate whether remedial goals have been achieved at sub-areas where statistical applications are appropriate, the $UL_{0.95}$ will be calculated using the assigned probability distribution and statistical parameters calculated for the data. The $UL_{0.95}$ calculated for each sub-area will then be compared with the risk based remedial goal of 1396 mg/kg to evaluate whether acceptable concentrations of lead in soil have been achieved.

5.5 Censored Data

The true concentration of verification sample data below the laboratory reporting limit (5.0 mg/kg) is unknown. Data sets containing these types of data are said to be censored on the left because data values below the reporting limit are not available. These missing data make it difficult to summarize and compare data sets and can lead to biased estimates of the mean, variance, trends, and other population parameters.

The following are four commonly applied methods recommended by Gilbert for handling data below the reporting limit: (1) report the datum as the reporting limit (this method may be applicable to the data generated during this project; however, it is unduly conservative); (2) ignore the datum below the reporting limit (this method was not suitable because it would eliminate data which accurately verifies achievement of the remedial goal); (3) report the

datum as zero (this method is not suitable because it under-reports the potential for lead being present in any of the samples); and (4) report the datum as a value between zero and the reporting limit (such as one half the reporting limit).

For samples with concentrations of lead below the reporting limit, a value of one half of the reporting limit will be assigned. This approach allows for an unbiased estimation of the mean.

6.0 REPORTING

It is the District's intent to transmit raw and statistically evaluated verification data for sub-areas to DTSC during the course of the Phase I lead abatement project. This initial reporting is expected to be an informal process, the purpose being to have DTSC participate in the process of demonstrating that the remedial goals have been met in each sub-area. It is anticipated that timely decision-making will be needed so that remediation equipment and labor can be efficiently utilized.

A second and more formalized reporting will occur following completion of the Phase I lead abatement. Within four weeks following completion of onsite remedial work, the District will prepare and submit to DTSC a report presenting the data collected under this VSAP. The report will summarize the data, present the results of the statistical analysis, and provide conclusions regarding attainment of remedial goals in each sub-area.

7.0 REFERENCES

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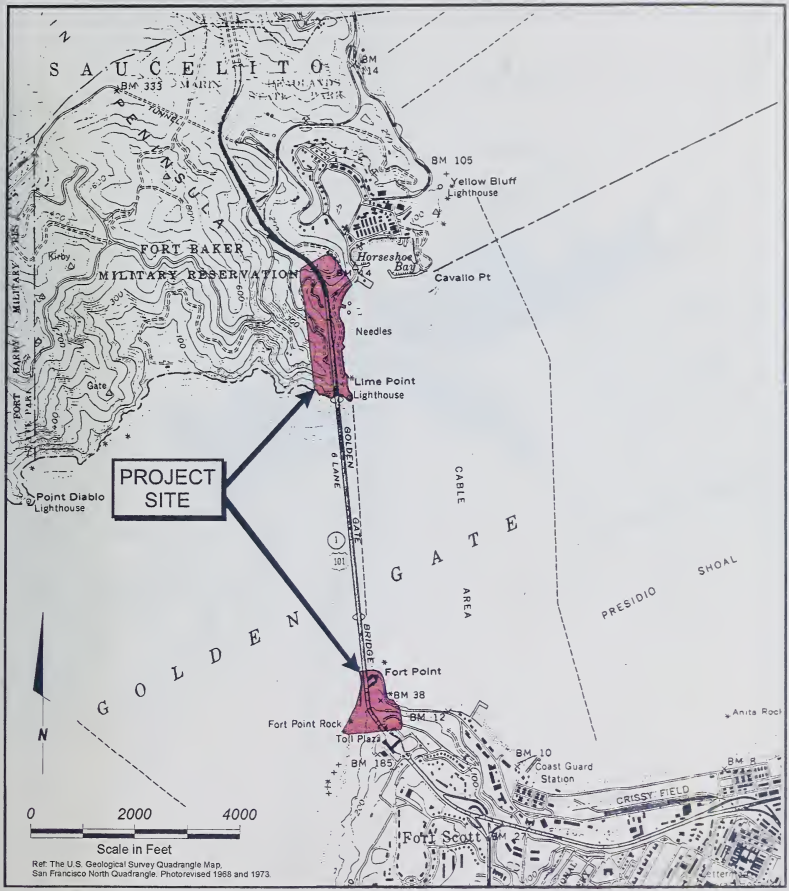
PLATES



Ref: The U.S. Geological Survey Quadrangle Map, San Francisco North Quadrangle. Photorevised 1968 and 1973.

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Site Location Map
Verification Sampling and Analysis Plan
Phase I Lead Abatement Project
Golden Gate Bridge Highway and Transportation District
Marin and San Francisco Counties, California

PLATE 1

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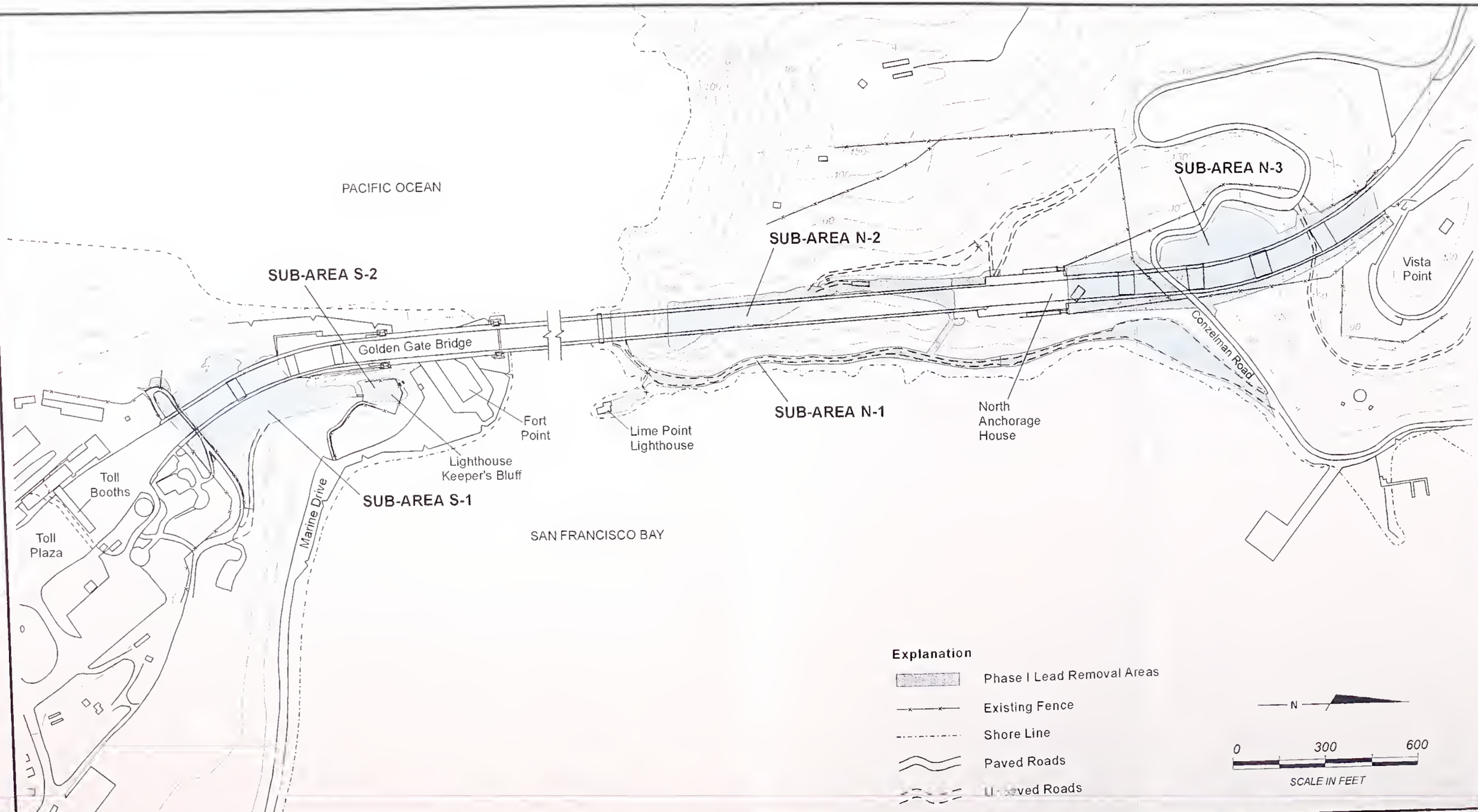
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



PES Environmental, Inc.
Engineering & Environmental Services

Site Plan
Verification Sampling and Analysis Plan
Phase I Lead Abatement Project
Golden Gate Bridge, Highway and Transportation District
San Francisco and Marin Counties, California

PLATE 2

272.0301.001	27203_P2.CDR	PJS	12/96
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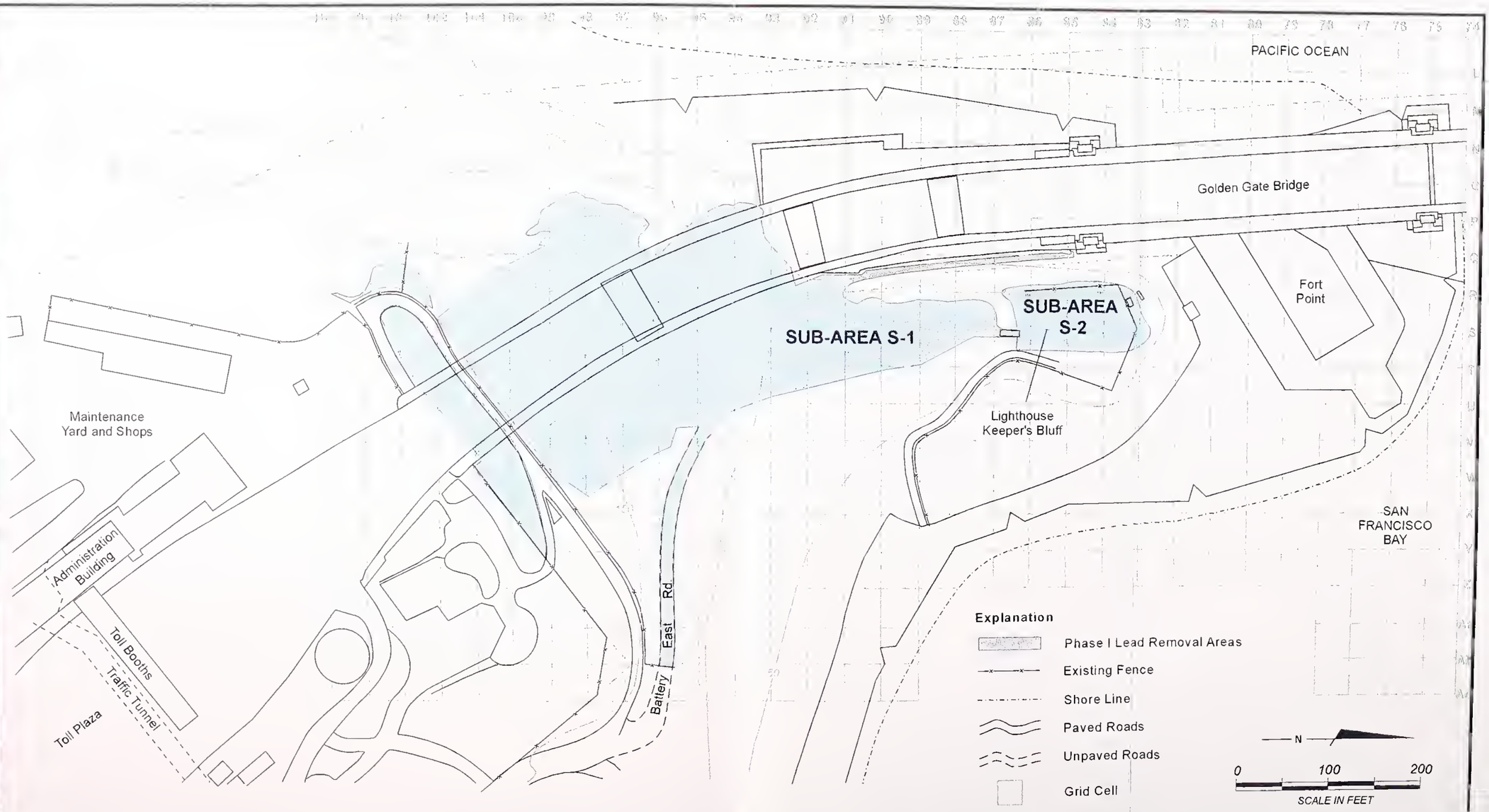
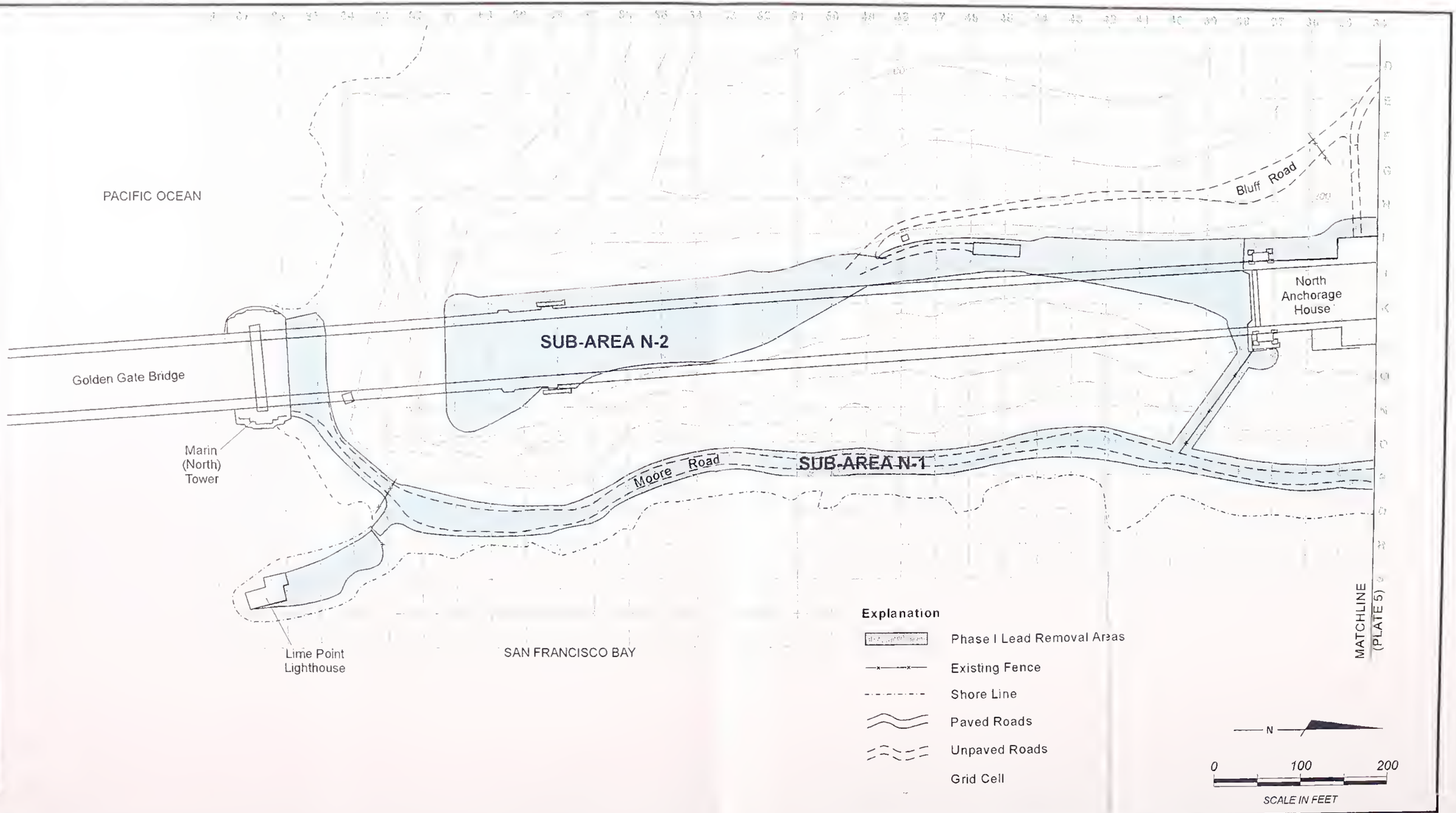


PES Environmental, Inc.
Engineering & Environmental Services

Removal Areas - South Approach
Verification Sampling and Analysis Plan
Phase I Lead Abatement Project
Golden Gate Bridge, Highway and Transportation District
San Francisco and Marin Counties, California

PLATE
3

272.0301.001	27203_P3.CDR	DJS	12/96
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



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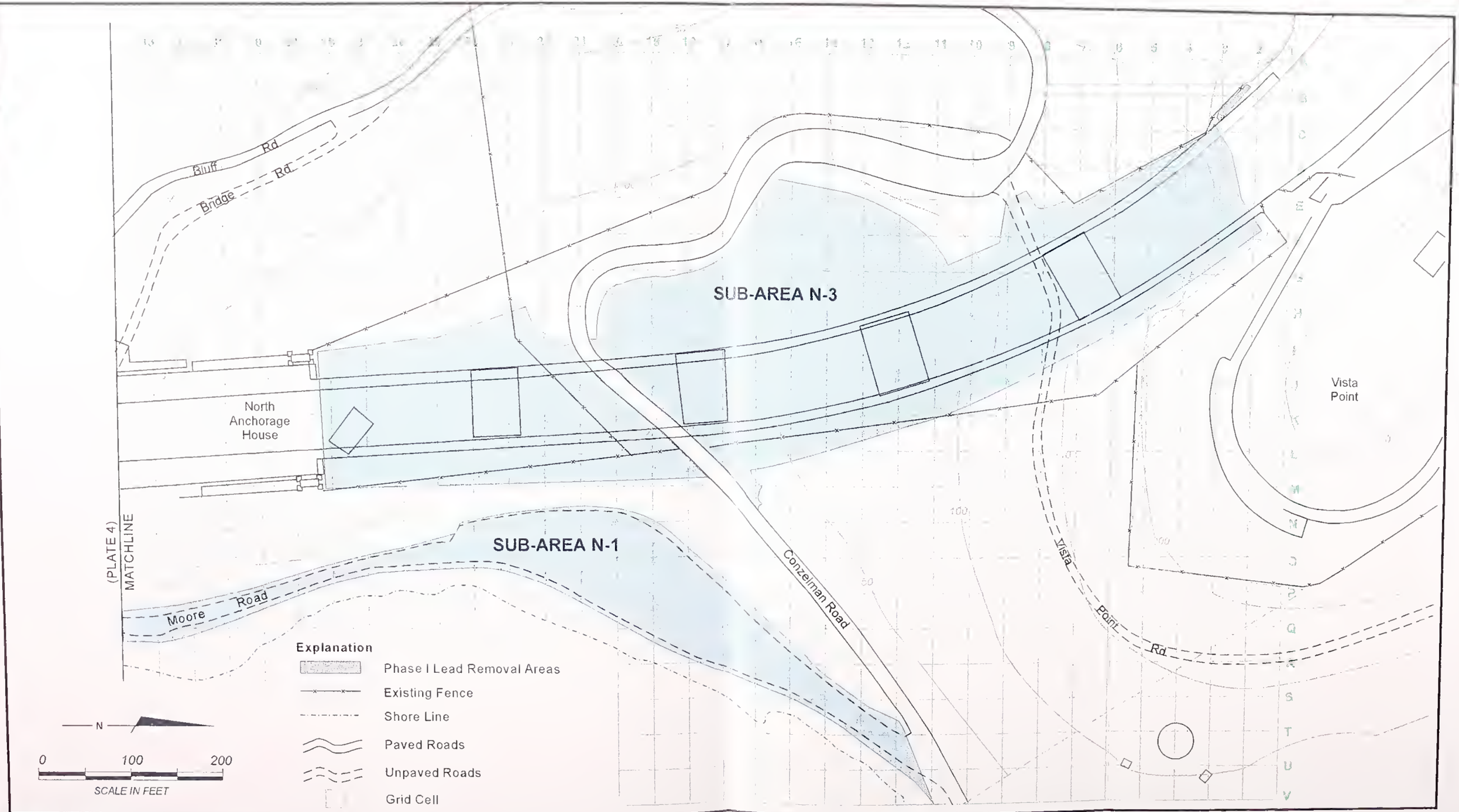
Removal Areas - North Approach (South of Anchorage House)
Verification Sampling and Analysis Plan
Phase I Lead Abatement Project
Golden Gate Bridge, Highway and Transportation District
San Francisco and Marin Counties, California

PLATE
4

272.0301.001	27203_P4.CDR	DJS	12/96
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



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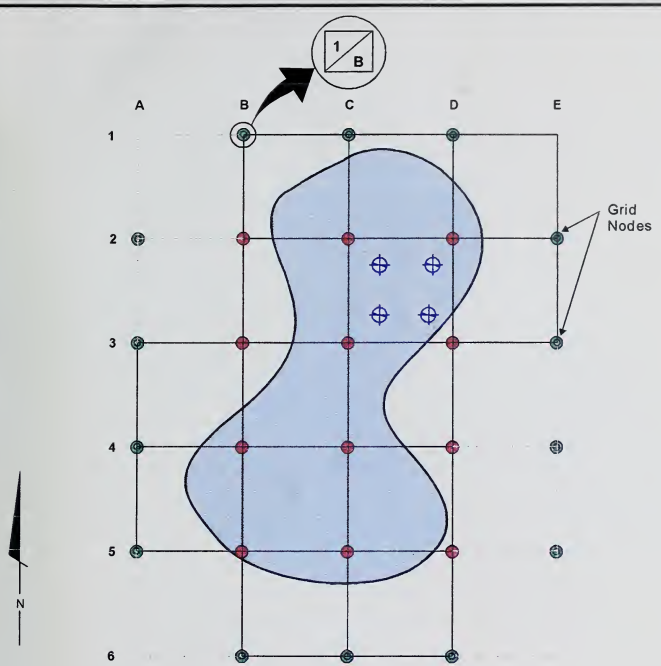
272.0301.001 | 27203_P5.CDR | DJB
JOB NUMBER | DRAWING NUMBER | REVIEWED BY

Removal Areas - North Approach (North of Anchorage House)
Verification Sampling and Analysis Plan
Phase I Lead Abatement Project
Golden Gate Bridge, Highway and Transportation District
San Francisco and Marin Counties, California

PLATE 5

12/96
DATE



Explanation

- Grid Node (located and staked by field crew following removal action)
- Grid Node (located and staked by surveyor prior to removal action)
- Grid Cell Boundary
- Composite Sub-Sample Location
- 1/B Grid Cell Identification (cell identification refers to north west grid node)
- Generalized Removal Subarea

PES Environmental, Inc.
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Generalized Grid Schematic
Verification Sampling and Analysis Plan
Phase I Lead Abatement Project
Golden Gate Bridge Highway and Transportation Distsrict
Marin and San Francisco Counties, California

PLATE 6

272.0301.001	27203_G1.CDR	AAB	12/96
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

APPENDIX A

FIELD FORMS

PES Environmental, Inc.
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PAGE	OF
DATE:	

DAILY FIELD REPORT

PROJECT:	
JOB NO.:	
PROJECT MANAGER:	
RECORDED BY:	

TIME	DESCRIPTION, COMMENTS, NOTES, ETC.

ATTACHMENTS: ☐ NO ☐ YES

DESCRIPTION:

SIGNATURE

Sample Log

Sub-area	Cell Identification	Sample Number	Samplers	Surficial Lithology	Sample Date	Sample Time	Laboratory	Sample Plan Deviations	Signatures

PES Environmental, Inc.
Engineering & Environmental Services

1682 Novato Blvd.
Suite 100
Novato, CA 94947

(415) 899-1600
FAX (415) 899-1601

PROJECT NAME _____

PROJECT # _____

DATE _____ TIME _____

SAMPLE # _____

ANALYSIS _____

NOTE/PRES. _____

PES ENVIRONMENTAL, Inc.
Engineering & Environmental Services

CHAIN OF CUSTODY RECORD

NOVATO, CALIFORNIA 94947
(415) 899-1600 FAX (415) 899-1601

JOB NUMBER: ____________

NAME / LOCATION: ____________

PROJECT MANAGER: ____________

SAMPLERS: ____________

RECORDER: ____________

DATE				SAMPLE NUMBER / DESIGNATION
YR	MO	DY	TIME	

SOURCE CODE	MATRIX					# CONTAINERS & PRESERV.								DEPTH IN FEET	COL MTD CD	QA CODE
	Water	Sedim't	Soil	Oil		Unpres.	H_2SO_4	HNO_3	HCl	Filtered						

ANALYSIS REQUESTED															
EPA 601 / 8010	EPA 602 / 8020 (BTEX)	EPA 624 / 8240	EPA 625 / 8270	TPHg by 5030 / 8015 (mod)	TPHd by 3550 / 8015 (mod)										

NOTE

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE	TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE	TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE	TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE	TIME
DISPATCHED BY: *(Signature)* / DATE / TIME	RECEIVED FOR LAB BY: *(Signature)*	DATE	TIME
METHOD OF SHIPMENT			

WHITE–Laboratory COPY YELLOW–Project Office Copy PINK–Field or Office Copy

APPENDIX B

QUALITY CONTROL PROCEDURES

APPENDIX B

QUALITY CONTROL PROCEDURES

B-1 Purpose

These quality control procedures (QC) have been prepared for the Phase I Lead Abatement Verification Sampling and Analysis Plan to be implemented on behalf of the Golden Gate Bridge, Highway and Transportation District at the Golden Gate Bridge. The purpose of the Quality Assurance (QA) program is to establish uniform procedures, guidelines and inspection protocols designed to produce environmental data of acceptable quality. The following sections describe the QC procedures which will be followed to meet this objective.

B-2 Data Quality Objectives

The data quality objectives (DQOs) specify the quality of data required to support remedial completion decisions. Measurements of the quality of data include the following parameters: precision, accuracy, representativeness, completeness, and comparability (PARCC).

B-3 Procedures for and Frequency of Calibration

Procedures for the calibration of equipment and instrumentation to be used in the performance of verification sampling are described in this section. Included are descriptions of the procedures or references to applicable standard operating procedures, frequency of calibration, and the calibration standards to be used.

B-3.1 Field Instruments

Field instruments will include surveying equipment used to plot sampling cell grid locations. These instruments may include GPS receivers or traditional levels and transits. This equipment will be calibrated by measuring a known location, or by the vendor or subcontractor who will be providing the surveying services.

B-3.2 Laboratory Instruments

Laboratory instruments will be calibrated in accordance with and at the frequency recommended by EPA guidelines and the laboratory QA manual.

B-4 Laboratory Analytical Program

The chemical and physical analyses of soil samples collected during the verification sampling will be performed by California-certified analytical laboratories. All analyses will be performed using EPA, State of California, or other approved methods for analyses of lead and zinc.

The analytical level of data quality will be EPA Level III (EPA, 1987a). In addition to meeting Level III requirements, laboratories will be certified by the California Department of Health Services, to perform hazardous waste testing.

The laboratory will retain documentation required by EPA's SW-846, Chapter One, Volume 1B (EPA, 1986b) for analytical data not included in the standard documentation packages. The documentation retained by the laboratory will include: the initial calibration curve and corresponding daily calibration curve, including raw data for initial instrument calibration, continuing calibration, and blank sample results.

Sample analytical results are referred to as "data deliverables." By requiring the analytical laboratory to retain documentation for later generation of data validation packages, only if needed, the amount of paperwork produced by the sampling program will be greatly reduced without sacrificing the validity of data.

The goals for laboratory accuracy, precision, and completeness will be based on the results of analyses of matrix spike and matrix spike duplicate (MS/MSS) using spike compounds specified under the CLP protocol. The goals for laboratory accuracy and precision are presented in Table B-1 for the soil analyses.

B-5 Data Validation, Reduction, and Reporting

Data collected during the verification sampling will be appropriately identified, validated and included in the final report. This section presents the guidelines for data validation, reduction, and reporting.

B-5.1 Field Measurement Data Validation

Validation of data obtained from field measurements will be performed by senior personnel. Validation of data collected in the field will be performed by checking procedures used in the field and comparing the data to previous measurements.

The following reporting requirements will be followed for field data:

Horizontal Locations of Sampling Sites: Horizontal locations of cell boundaries will be determined to a resolution of no greater than 3 feet.

Lithologic Description of Samples: Lithologic description of samples collected will be limited to noting whether the sample contains road base material, spent SBM, soil, rock, or a mixture of these materials. The presence of paint chips will also be noted if observed by the sampler.

B-5.2 Internal Laboratory Analytical Data Validation

The first level of review and consequent data reduction, validation and reporting is done at the laboratory. These tasks will follow the protocols outlined in the methods presented in the laboratories individual standard operating procedures (SOP's) and QA/QC programs and the EPA guidance document SW-846.

To facilitate data validation, the following information will be included in all laboratory reports, as appropriate for the type of analysis:

- Sample Custody;
- Instrument Performance;
- Sample Integrity;
- Parameter Identification and Quantification;
- Precision; and
- Accuracy.

The specific requirements for validation of each of the above items are described below.

B-5.3 Sample Custody

For each sample or lot of samples received, analyzed and reported by a laboratory, the signed copy(s) of the chain-of-custody form(s) will be attached to the report, together with any appropriate comments or observations related to sample quality (e.g., temperature, custody seals, headspace). For each sample analyzed, the laboratory sample and batch numbers will be identified with each report. In addition, for each sample analyzed, the date and time the sample was received, prepared and/or extracted (if appropriate), and analyzed will also be included with each report.

B-5.4 Instrument Performance

For each sample or lot of samples received, analyzed, and reported by the laboratory, the following information will be provided, as appropriate:

- Identification of the instrument and appurtenant equipment in sufficient detail to allow later evaluation of any instrument used for analysis;
- Detection and reporting limits for each parameter for each analysis;
- Raw data for all initial calibration analyses; and
- Raw data for all continuing calibration analyses.

B-5.5 Sample Integrity

For each sample or lot of samples received, analyzed, and reported by the laboratory, the laboratory will analyze internal method blank samples on a minimum frequency of one per lot or greater as required by the method, to assess the potential for sample contamination by laboratory operations. All raw data for each blank sample analyzed will also be submitted with each report.

B-5.6 Parameter Identification and Quantification

For each sample or lot of 20 samples received, analyzed, and reported by the laboratory, the laboratory will provide the information listed in EPA guidance document SW-846. In general, the laboratories will provide all relevant raw data for each type of analysis necessary to validate parameter identification and quantitation.

B-5.7 Precision

Precision: A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation or relative percent difference (RPD). Various measures of precision exist depending upon "prescribed similar conditions".

Sampling precision will be evaluated by collecting and analyzing field duplicate samples and preparing and analyzing laboratory duplicates from one or more field samples. Results from the field duplicate samples provide data on measurement precision while results from laboratory duplicates provide data on analytical precision. Sampling precision is evaluated by subtracting analytical precision from the measurement precision.

For each sample or lot of samples received, analyzed, and reported by the laboratory, the laboratory will analyze, on a minimum frequency of one per lot of 20, internal matrix duplicate samples for each analysis type. The laboratory will also provide all raw data for the duplicate analyses.

B-5.8 Accuracy

Accuracy: The degree of agreement of a measurement (or an average of measurements of the same parameter or property), X, with an accepted reference or true value, T. Usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system.

Analytical accuracy will be assessed by analyzing known and unknown QC samples and matrix spikes.

For each sample or lot of samples received, analyzed, and reported by the laboratory, the laboratory will analyze, on a minimum frequency of one per lot, internal matrix spike and matrix spike duplicate samples for each analysis type. The laboratory, where appropriate, will also use and analyze surrogate spikes for every environmental and QC sample. The laboratory will provide all raw data for the spike sample analyses.

B-6 Quality Control Checks

Two types of QC checks are employed to evaluate the performance of laboratory analytical procedures: field QC checks and laboratory QC checks. The QC checks represent the controlled samples introduced into the sample analysis stream that are used to assess the accuracy and precision of the chemical analysis program. The QC check samples are introduced or analyzed on the basis of the size of sample lots. A sample lot will consist of no more than 20 samples for analysis. On occasion, a sample lot may be slightly less than 20 samples, based on the nature of the field activities.

B-6.1 Field QC Checks

Field QC checks are control samples that are introduced blind (i.e., numbered, packaged and sealed in a manner identical to other samples) to the laboratory(s) from the field. Field QC samples will consist of sample duplicates. All QC samples will be given a unique sample number in the field that will not indicate to the laboratory that the sample is a QC check. The QC samples are described below. The matrix- and analysis-specific description and frequency of field/external QC samples is also presented below.

B-6.1.1 External Duplicates

In general, for each analysis used, field duplicates will be submitted to the laboratory performing the analysis. One duplicate sample is collected and submitted at a minimum frequency of one per 20 samples or one per day, whichever is greater, per analytical method.

B-6.1.2 Laboratory QC Checks

Specific requirements and procedures for laboratory QC will be monitored by the laboratory to verify that analytical data of known quality is generated. Corrective action will be taken whenever needed. Project QA staff will examine the QC information provided by the laboratory as a secondary review for all chemical data. Additional QC samples may be generated by the laboratory according to method specifications. Laboratory QC samples include the following components:

B-6.1.2.1 Standards

Calibration standards and check standards with known concentrations are prepared in the laboratory from standards obtained from EPA, National Institute of Standards and Technology, or equivalent. These standards will be used in accordance with the requirements of the analytical method.

B-6.1.2.2 Internal Blanks

Internal blanks are used to detect system bias introduced in the laboratory. A laboratory pure water (organic-free, distilled) blank is processed through all sample preparation procedures and analyzed as a method blank. A reagent blank can be used in place of the method blank for nonaqueous samples. One blank will be analyzed per lot of samples, or one per day, whichever is more frequent.

B-6.1.2.3 Internal Duplicates

A field sample will be split into two portions during laboratory preparation. Each portion is then processed through the remaining analysis steps as a duplicate. Precision information will be provided for evaluation variability in preparation and analysis. One pair of duplicates will be analyzed per lot of samples or one per day, whichever is more frequent.

B-6.1.2.4 Internal Spikes

An internal spike (matrix spike [MS]) is prepared in the laboratory by adding a known amount of the target analytes into the sample prior to laboratory preparation. These spikes simulate the matrix effect on analyses for field samples. Percent recoveries are calculated for these target analytes as a measure of the accuracy of the total analytical method. The spiked samples may also be analyzed in duplicate (matrix spike duplicate [MSD]) for an assessment of the

precision of the analytical method. A MS/MSD pair will be analyzed at a general frequency of one per lot (20 samples) or as specified by the method. For each MS/MSD, sufficient sample will be collected in the field (normally triplicate volumes). Spiking levels for MS/MSDs will follow those levels specified by the EPA methods. If method specific levels are unavailable, spiking concentrations will be set at concentrations similar to those detected during the course of the verification sampling.

B-6.1.3 External Data Validation

Chemical data will be evaluated by the Project QC officer or representative according to the detailed procedures outlined in Section B-5.2 to independently validate the laboratory data. The evaluation will also include an inventory of all laboratory deliverables and checking internal and external QC results to see that they are within specified limits. This inventory may include review of the following items:

- Holding Times - Holding times are checked against those specified in the QA/QC objectives to determine if a sample was analyzed within the holding time specified for that analytical method. The number of days elapsed between sample collection and sample analysis (or extraction, if applicable) is calculated. The holding times for analysis of lead and zinc per SW-846 is 180 days.

  If holding times are exceeded, sample results will be tagged as estimated ("J"). Gross violations of holding times may result in qualifying the data as unusable ("R").

- Method Blanks - Method blanks are reviewed to determine that they were prepared and run with the applicable sample batch. Target analytes that were detected in method blanks are tabulated.

- Matrix Spike/Matrix Spike (MS/MSD) Duplicate PRs - Matrix spike PRs are checked to see if they are within the acceptance limits presented in SW-846. When acceptance limits are not specified in SW-846, laboratory acceptance limits based on historical data are used. MS/MSD RPDs outside of acceptance limits may result in qualification of the data as estimated ("J").

- Laboratory Control Sample (LCS) PRs - LCS PRs are checked to see if they were within laboratory acceptance limits that are based on historical data. LCS PRs outside of acceptance limits may result in qualification of the data as estimated ("J").

- LCS RPDs - LCS RPDs are checked to see if they were within laboratory acceptance limits that are based on historical data. LCS RPDs outside of acceptance limits may result in qualification of the data as estimated ("J").

- Field Duplicate RPDs - Field duplicate pairs are compared to check if the RPDs are within the acceptance limits specified in the QAPP in order to assess if the analytical results were representative of the same analyte concentrations. If RPDs are above the specified acceptance limits, data for the duplicate pairs may be qualified as estimated ("J") after a review of other QC criteria. If RPDs are grossly above the acceptance limits, the laboratory will be contacted and asked to review their results. If an explanation is not found, the data may need to be tagged as unusable.

Other criteria that will be used to validate data integrity on a routine basis are listed below:

1. Verification of correct sampling procedures.

2. Verification of chain-of-custody procedures.

B-6.1.4 Data Reporting Requirements

Procedures for completing sample labels, chain-of-custody forms, entries into the field logs and the transfer of custody from the field personnel to the laboratory custodian are presented in Section 3.4.

After the sample has entered the laboratory system, data entry from the analysis process is generally automated. Upon completion of the analysis, the data are reviewed and validated. Upon validation, a final report is generated and sent to the owners representative. This report may be in digital format on disk, or in hard copy.

B-6.2 Performance and System Audits

The project QA Officer will monitor and audit the performance of the QA procedures outlined in this VSAP. Both system and performance audits of the field and analytical QC programs will be conducted. System audits involve inspection of equipment for sampling and data gathering to evaluate the effectiveness of the methods and technologies employed. A system audit will be performed in the initial stages of a field activity and on a regularly scheduled basis for the lifetime of the project. Performance audits involve the inspection of field and laboratory activities to verify that the standardized procedures established herein are executed to provide for accurate data generation and conformance to specifications. Any QA questions and/or problems that would necessitate resampling, delay the delivery of a submittal, or delay the completion or implementation of a required task will be promptly reported to the District and DTSC.

B-6.2.1 Field Activities

To assure implementation of the procedures and standards established by the QA objectives, the QA Officer (or designated representative) will perform audits of the project field work. Audits will include, but not be limited to, inspection of field operations and records, laboratory testing and chain-of-custody records, and maintenance of field activity project files. The frequency of system audits of field activities will be determined by the QA Officer. At a minimum, an audit will be conducted during the initial stage of the field sampling program and as appropriate.

A field activities system audit will involve an onsite visit by the QA Officer (or designated representative). The QA Officer will be notified before beginning work in order to schedule a system audit in the early stages of field work so that the resolution of corrective action will not adversely affect the project schedule nor impact a significant portion of the field work. The field audit schedule will be dependent upon the extent of the field activities.

Field audits may include the following:

1. Confirm that relevant information is entered on field activity forms.

2. Verify collection of field measurements and proper record keeping.

3. Verify sample collection, shipping, and chain-of-custody procedures. This will include the inspection of equipment decontamination.

4. Verify QA programs of analytical and physical testing laboratories. This may include collecting split samples or submitting blind samples for chemical analysis.

5. Verify proper maintenance of records.

During the course of field activities of extended duration, performance audits will be conducted by the QA Officer at a regular frequency, and at least every two months depending on project activity. This frequency may be adjusted by the QA Officer, as appropriate. The performance audits are to assure that the work is progressing in a controlled manner, satisfies data quality requirements, and satisfies all quality requirements as specified by the QA/QC objectives. Additionally, as part of the performance review, the QA Officer may audit material that is maintained in the data management files.

Corrective action resulting from an audit will be requested through the QA Officer. Requests for corrective action must be resolved to the QA Officer's satisfaction. The method for verification of corrective action and the time period for completion will be stipulated in the QA Officer's audit report. Completion of corrective action will be verified and documented as a QA record. After verification of corrective action is complete, the QA Officer will issue a statement closing the audit.

B-6.3 Preventive Maintenance

All laboratory equipment will be routinely maintained as specified by the standard operating procedures of the laboratory.

B-6.4 Procedures for QC Assessment of Chemical Data

This section summarizes QC procedures for assessing the validity of the chemical data derived from the sampling and chemical analysis tasks and the format for presenting the results of the QA/QC evaluations in reports.

The data validation procedures will be used by the Project QA Officer (or designated representative) for assessing duplicate samples and checking blank samples that are generated internally by the laboratories in accordance with the QC procedures. The purpose of implementing these procedures is to verify that the chemical data generated during the investigation are accurate, precise, complete and comparable, and therefore, representative of site conditions. Detailed discussions of the procedures for the data validation, the format for QC data assessment, and reporting are presented below.

B-6.4.1 Assessment of Accuracy, Precision, and Completeness

Chemical data collected during the verification sampling are validated in terms of accuracy, precision, and completeness for both the analytical laboratory and field sample collection programs. This validation includes a review of RPD, percent recovery, holding times, and other sampling documentation. The primary goal of the program is to evaluate whether the data reported during the investigation is representative of conditions at the Phase I Lead Removal area. To meet this goal, a combination of qualitative evaluations and comparisons to project QA objectives is used to check the quality of the chemical data. Internal laboratory statistical analyses of QC samples will be used to validate the analytical procedures used by the laboratory. Comparison of field QC sample results to project QA goals will be used to evaluate the field sampling and handling procedures, as well as the laboratory analytical procedures. If problems arise and the data are found to deviate from data from previous analyses or surrounding conditions, the data will be annotated. Sample re-collection and analysis will only be performed when insufficient data are available to support the decision-making process or when it is necessary to meet QA goals.

The assessment of data validity will be based on the three types of QC samples listed in Section B-6 (spikes, blanks, and duplicates). Because the QC samples described above are generated for analysis both externally in the field for blind submittal and internally by the laboratories, a system of cross-checking has been established that provides independent evaluation of the chemical data both internally and externally. The procedures for evaluating both the field and laboratory QC data are the same and are presented below for blanks, duplicate, and spike samples.

B-6.4.2 Blanks

The evaluation procedure for blanks is a qualitative review of the chemical data reported by the laboratories. The procedure for assessing blank samples will be as follows:

1. Tabulate the data from the blank samples.

2. Identify any blank samples in which analytes were detected.

3. If no analytes were detected in any blank samples, the data will be entered into a summary report.

4. If analytes are detected in laboratory blank samples, the concentration of these chemicals and their relationship to the concentration of the same chemicals in associated environmental samples will be evaluated for their impact on data quality.

If the level of laboratory blank contamination is severe, the Project QA Officer will notify the laboratory and will review other recent results from blank samples from the laboratory to determine if it was an isolated incident. Depending on the significance of the problem, the Project QA Officer will submit additional blank samples to the laboratory to verify that the problem exists and/or to determine if the problem has been corrected.

B-6.4.3 Duplicates (Precision)

The procedure for assessing precision through the use of field and laboratory duplicates and MS/MSD pairs is as follows:

1. Tabulate duplicate data and calculate the absolute value difference, average, and relative percent difference (RPD) as shown below for each duplicate pair:

$$\frac{(x_1 - x_2)}{\bar{x}} = \text{RPD}$$

where:

x_1 = concentration for Sample 1 of duplicate

x_2 = concentration for Sample 2 of duplicate

$\bar{x}$ = mean of Samples 1 and 2

RPDs will not be calculated in cases where the concentration of one analyte of the duplicate pair was below the reporting limit.

2. Identify duplicates that exceed the project (method) precision goals.

3. Qualitatively evaluate precision in terms of the degree that data exceed the project goals. If data quality problems arise, the analytical laboratory will be notified for corrective action, as appropriate. Data will not be removed from the database as a result of these procedures. Instead, data will be flagged with appropriate notation.

B-6.4.4 Spikes (Accuracy)

The procedures for assessing accuracy through the use of MS/MSD are as follows:

1. Tabulate spike sample data and calculate the percent recovery as shown below for each type of spike sample and spiking compound:

$$\text{percent recovery} = \frac{(T - X)}{A} \times 100$$

where:

T = total concentration found in spiked sample
X = original concentration in sample prior to spiking
A = actual spike concentration added to sample.

2. Identify spikes that exceed the project (method) percent recovery (accuracy) goals.

3. Qualitatively evaluate accuracy in terms of the degree that data that exceed the project goals. If the QC goals are exceeded, the laboratory will be notified and the data from that period of time will be evaluated for the compound that exceeds the limits and corrective action will be taken, as appropriate. Data will not be removed from the database as a result of these procedures. Instead, data will be flagged with appropriate notation.

B-6.4.5 Completeness

Completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

A dense sampling grid (approximately 27 samples per acre) will be used and data generated from sample analyses will address completeness. Level III (offsite analytical laboratory) analytical methods will be utilized and are expected to exceed 80 percent completeness (EPA, 1987).

The completeness of the investigation data represents an estimate of the volume of data expected from the field programs versus the amount of data actually entered into the data base that is available for interpretation. Measurement completeness (C) can be described as the ratio of acceptable measurements obtained for the total number of planned measurements for an activity. For this extended meaning, completeness is defined as:

$$C = \frac{\text{number of acceptable items}}{\text{total number of planned items}}$$

The project goal for completeness using this definition is 90 percent.

Completeness is also assessed prior to preparation of data reports and includes checking that all entries in the database are correct, properly entered, and that typographical errors (if any) in the database are corrected.

B-6.4.6 Representativeness

Representativeness: Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Representativeness for shallow verification soil sampling will be addressed by collecting and compositing relatively undisturbed samples following remedial action at locations from with in an unbiased grid superimposed on the remediation areas.

The representativeness of data will be qualitatively assessed by evaluating whether or not sample collection and analytical procedures described by the QA/QC procedures were followed. Furthermore, descriptions of the design and implementation phases of the sampling program as actually carried out will be assessed for the degree to which representative samples of soil were obtained. Specifically, the site sampling layout, including sampling locations will be reviewed.

B-6.4.7 Comparability

Comparability: Expresses the confidence with which one data set can be compared to another.

Data will be collected and analyzed using State-approved techniques to allow comparison with data collected previously at the site.

The comparability of data generated in this phase of work with previous data sets will be qualitatively assessed. Comparisons of sampling and analytical protocols, preservation methods, reporting units, QA/QC programs, data quality objectives, precision and accuracy estimates, and the siting of sampling stations will be made between data sets. If the above factors are generally equivalent, then the data sets will be considered comparable.

B-6.5 Corrective Actions

If any occasions arise that indicate field or laboratory measurement error has occurred, one or more of the corrective actions described below will take place. Noncompliance may either be field or laboratory related and observed during the performance of an activity or an audit. Corrective actions will be identified and implemented on a case-by-case basis by the QA Officer and/or Project Manager and performed under their supervision. The following sections describe the problems that may be encountered in both the field and laboratory and the appropriate corrective actions.

B-6.5.1 Field Situations

The need for corrective action will be identified as a result of the field audits previously described. If problems become apparent that are identified as originating in the field, appropriate corrective action will be identified and implemented. If the corrective action does not resolve the problem, appropriate personnel will be assigned to investigate and evaluate the cause of the problem. Once a corrective action is implemented, the effectiveness of the action will be verified such that the end result is elimination of the problem.

B-6.5.2 Laboratory Situations

The need for corrective action resulting from not meeting QC criteria and/or from QA audits will be initiated by the laboratory QA/QC Manager in consultation with the project QA Officer. Corrective action may include, but not be limited to:

- Reanalyzing the sample, if holding time criteria permit;
- Evaluating and amending sampling and analytical procedures;
- Accepting data with an acknowledged level of uncertainty; and
- Resampling and analyzing.

In the event that the above corrective actions are deemed unacceptable, an alternate laboratory may be selected to perform necessary or appropriate verification analyses.

B-6.5.3 Immediate Corrective Action

Any equipment and instrument malfunctions will require immediate corrective actions. The laboratory maintains working procedures that identify appropriate immediate corrective actions to be taken when a control limit has been exceeded. They provide the framework for uniform actions as part of normal operating procedures. The actions taken should be noted in field or laboratory logbooks, but no other formal documentation is required unless further corrective action is necessary. These on-the-spot corrective actions will be applied daily as necessary.

B-6.5.4 Long-Term Corrective Action

The need for long-term corrective action may be identified by standard QC procedures, control charts, and/or performance or system audits. Any quality problem that cannot be solved by immediate corrective action falls into the long-term category.

The essential steps in a corrective action system are:

- Identification and definition of the problem;
- Investigation and determination of the cause of the problem;
- Determination and implementation of a corrective action to eliminate the problem; and
- Verification that the corrective action has eliminated the problem.

Documentation of the problem is important in corrective action. The responsible person may be an analyst, laboratory QA Manager, sampler, project QA Officer, or the Project Manager. In general, the project QA Officer will investigate the situation and determine who will be responsible for implementing the corrective action. The project QA Officer will verify that the corrective action has been taken, appears effective, and, at appropriate later dates, verify that the problem has been resolved. The required corrective action will be documented by the QA Officer and the manager for field activities. The corrective action will be discussed with the District and DTSC prior to implementation, if the severity of the problem warrants such discussion.

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